SECTION SUBMITTED BY THE BUREAU OF ENTOMOLOGY

FOR THE CONFIDENTIAL MEMORANDUM

ON THE MEDITERRANEAN FRUIT FLY,

PREPARED FOR USE OF THE SUBCOMMITTEE

OF THE HOUSE COMMITTEE ON APPROPRIATIONS

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MEDITERRANEAN FRUIT FLY.

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The following discussion of the Mediterranean fruit fly from the standpoint of history, distribution, biology, etc., and as to conditions obtaining in other countries reached by this pest, has been prepared at the request of the Committee on Appropriations of the House of Representatives.

History and Distribution.

The Mediterranean fruit fly is now believed to be "native" to the coastal region of West Africa below the "humo", on the basis of its occurrence in that region under what appear to be primitive conditions and particularly on the basis of discovery there of important parasitic enemies.

It was first collected and recorded from the Island of Mauritius in 1817--evidently, from other conditions, an introduction.

It spread slowly during the last century (1827-1900), evidently by carriage of infested fruit on vessels to islands off northwest coast of Africa and eventually to all Mediterranean countries.

The infestation of the Bermuda Islands is believed to date from 1865, when a vessel with a cargo of fruit from the Mediterranean was forced by a storm to there discharge its cargo.

South Africa became infested about 1840; East Africa at various points not until the beginning of the present century, including the Island of Madagascar.

The fruit fly reached Brazil 25 or 30 years ago and perhaps much earlier.

Argentina was at one time believed to be infested with the fly but two intensive surveys have failed to show its presence, which, together with favoring conditions for its multiplication there, makes the earlier report unquestionably erroneous, doubtless based on confusion with the native fly which occurs in North Argentina.

The development of refrigeration for ocean steamers, making it possible to hold fruit for long periods, is in a way responsible for the introduction of the fruit fly into such remote districts as Australia, New Zealand, and Hawaii. West Australia was reached in 1897, East Australia (New South Wales) in 1898, and the entire island is now invaded, and also the adjoining Island of Tasmania. Several temporary establishments of this pest were effected in New Zealand between 1901 and 1908, but efforts were promptly made to eradicate it and these are claimed to have been successful.

The fruit fly was brought to Hawaii in 1910 through the agency of infested fruit on a ship from New South Wales. No fruit was landed, but the flies were swarming on the ship and easily reached the abundant fruit growing throughout the city, some of it within a short distance of the docks.

Effort to Exclude This Pest from United States.

The Mediterranean fruit fly was one of three pests specifically mentioned in the Federal Plant Quarantine Act of 1912, and concerning which the act was made immediately effective. Since that time, the Federal Government has enforced strict quarantine against the entry of host fruits and vegetables from all countries known to have been reached by this pest. In the course of such enforcement a great many interceptions of contraband fruit infested with this pest have been made, even at ports as far north as Boston, many at New York, at least one at a Florida port, and some 55 at Pacific ports, the latter chiefly concerning fruits and vegetables from Hawaii. However, hundreds of lots of contraband fruit not determined as infested have also been intercepted and destroyed and many of these may have been infested.

Long prior to 1912, California began a system of inspection at ports of entry of that State of plants and plant products for the purpose of excluding insect pests, including fruit flies--a service which was tremendously strengthened and increased following the appearance of the Mediterranean fruit fly in Transpacific islands and countries. California has continued this service at the expense of the State but it has been made part of the Federal port inspection service and the State inspectors have been commissioned to enforce the Federal Act. It may be noted here that a similar service was established by Florida in 1915, and since continued also at the cost of the State, but with similar incorporation as a part of the Federal service.

Possible Source of Florida Infestation.

The means of entry of this pest into Florida is not known. All that can be said is that it was almost certainly brought in with infested fruit which gained entrance either as contraband fruit through the regular channels of commerce or through illicit or unsupervised traffic. In the former case, the opportunity for introduction of such contraband is intimately related to the effectiveness of the port inspection forces--a branch of the service which has always been undermanned.

The Economic Importance of the Mediterranean Fruit Fly.

The economic importance of this pest has been made the subject of a special discussion, attached hereto, entitled "Mediterranean Fruit Fly Conditions in Other Countries Vs. United States." This statement discusses the conditions favorable or unfavorable to the fly in the various countries concerned and indicates the nature of the damage occasioned. These conditions are contrasted with climatic and fruit production conditions in Florida and other portions of the United States.

In brief, this insect is recognized the world over as perhaps the worst of all known fruit pests, and in practically all countries where climate and fruit conditions are favorable it has occasioned enormous losses, and has eliminated in some cases the production of certain types of fruit practically altogether. The discussion referred to indicates also the conditions of climate, of control, harvesting and marketing, in various countries which make it possible for the production and utilization of certain of the host fruits of the fly.

Life History and Habits.

The Mediterranean fruit fly as adult is a 2-winged insect, a little smaller than the common house fly, of a light resinous color, beautifully marked on the body with darker brown or black, and the wings also shaded with resinous bands. (See Circular PQCA 230, herewith). These markings and other structural characters make it possible for the specialist to separate this insect with accuracy from all other types of fruit and other flies.

The female fly can protrude a sharp egg-laying instrument (ovipositor) with the aid of which she burrows a hole through the rind or skin of fruits or vegetables for the purpose of depositing a small batch of eggs, usually about 6 at a time. The total egg-laying capacity of a female is unknown. One specimen in captivity deposited 622 eggs during a 5-months' period and when dissected after death still contained other eggs.

The life of the fly may be several months or, in exceptional cases, nearly a year, which adds enormously to its possibility for damage and for maintaining itself in the absence of fruits in which to breed, either in spring or fall or, in countries with mild winter climates, during the winter.

The eggs, in summer temperatures (70 to 80°) normally hatch within two days.

The larval period at similar temperatures may be as short as five days but probably normally is about 8 days. After the larva reaches full growth it makes openings to the surface of the fruit and at the end of the period escapes through these openings and falls to the ground.

The "pupal" period--understanding that to mean the period between the escape of the larva from the fruit, its entry into the soil and the emergence of the adult fly--may be as little as 6 days, but probably at temperatures indicated, is normally 9 or 10 days. This period is normally spent in the soil a short distance, rarely exceeding two or three inches, below the surface; or it may be spent in any crack or crevice, or even exposed, indoors or out.

The adult insect, if in the soil, burrows up to the surface, and, for

about 4 days, flies about and feeds on fruit juices or plant excretions, honeydew of insects, etc., mating during this period, and may then begin the deposition of eggs for a new generation.

The shortest time indicated in these figures for a complete generation--from egg to egg--is 17 days, with an average period of 23-24 days, this being for hot summer weather and favorable host fruit or vegetable conditions. During the period in fall, winter and spring, the fly becomes more inactive and all of these periods are lengthened. Under conditions such as obtain in Hawaii and Florida, some 12 annual generations and possibly more may be expected--averaging summer with winter conditions.

The rapidity of multiplication of the insect may be understood from this epitome of its life history. For example, and for purposes of avoiding exaggeration, if we take the number of descendants of a single female as 200 instead of a possibility of 600 or more, we would get for the first generation 100 males and 100 females; and for each succeeding generation we would again have 100 females as the multiplier. On this basis, at the end of the 5th generation, there would be theoretically a total of ten billion females (not counting the males) and this total could be reached, under Florida spring and summer conditions, in 4 or 5 months!

Incidentally, this power of multiplication, in the presence, from the fly standpoint, of unlimited fruit in which to breed, could account for all the fruit fly development in the intensely infested district at Orlando and the spread therefrom on the basis of an introduction in 1928. The percentage of infestation decreased rapidly beyond Orlando, which would be in entire accord with the belief that the spread throughout central Florida from Orlando as a center was due to normal drift and carriage of fruit from this center--taking into consideration motor traffic, week-end visits to the coast and other points of interest, etc., as well as actual movement of fruit commercially.

Hibernation of the Fruit Fly.

In many fruit fly countries the activity of the fly is merely slowed down in winter, namely, the egg, larval and pupal periods are more or less prolonged and the flies themselves may survive and be seen about trees on warm sunny days. In colder districts true hibernation may take place, as larvae in fruit or as pupae in soil or other situations, and possibly also as adult flies in such protections as are sought, for example, by the common house fly. Such successful hibernation may take place far north of the normal continuing occurrence of the insect. The Paris outbreak, referred to in the discussion of the behavior of the fruit fly in various countries, may have been of this nature, or possibly resulted from separate introductions with infested fruit.

History of Discovery in Florida.

That Orlando was the point of introduction of this pest in Florida would seem to be fully established by the intensity of the infestation there in a number of groves and its very rapid decrease outside of the immediate vicinity of the city. As was early determined, in 3 or 4 considerable groves in Orlando the infestation in grapefruit had reached, when discovered, 75 to 100 per cent, and minor infestation was found generally throughout the city and suburbs. The actual discovery of the Mediterranean fruit fly resulted from the examination of some grapefruit which had been obtained from a small experimental citrus planting in Orlando, utilized by the Bureaus of Plant Industry and Entomology of the Department of Agriculture and situated at a distance of about a mile from the heavily infested groves. This experimental, varietal planting in point of infestation was comparable to other points of minor infestation in the city, and had evidently been reached from the more heavily infested centers by the normal spread of the pest throughout the district. The discovery of infestation of this fruit was made on April 6, after most of the fruit in question had been consumed.

The larvae found were tentatively identified as possibly Mediterranean fruit fly and specimens in alcohol were brought by special messenger to Washington for determination, arriving the evening of April 9. Determination was made the morning of the 10th, confirming the identification, and on the afternoon of the same day the writer, in company with Dr. Baker, chief of the Tropical and Subtropical Plant Insects Division of the Bureau of Entomology, left for Florida. On arrival in Orlando the day following, the work of cleanup was already under way.

The details of the organization and quarantine and eradication work are are summarized in a statement furnished by request as a supplement to the writer's testimony in connection with the hearing on the Agricultural Department appropriation bill for 1931. A reprint of this statement is included with this document. This statement discusses also the control work undertaken in Southern States, necessitated by the movement in large quantities of Florida fruit into these States, which in a good many instances were later determined to be actually infested with maggots of the fly.

Another statement is included, namely, a mimeographed circular issued May 20, 1929, giving the history of the control effort up to that period and carrying a plate illustrating the fly, larvae and pupae, and another plate showing the larval characteristics of the Mediterranean fruit fly as contrasted with similar characters of other flies which might occur in fruit and be mistaken for the former.

Host Fruits and Vegetables.

As a brief statement, it may be said that the fly may infest practically all fruits and several important vegetables. The only positive exception to fruit is the pineapple. In the case of lemons and sour limes, however, the breeding of adult flies from perfect, i.e., unbroken or uninjured fruit has never been demonstrated, and hence for practical purposes

these fruits are not considered as hosts. The favored hosts are stone fruits, pear, apple, etc., and others with thin skin, including the coffee berry, the Surinam cherry, and many others; but in places where the climate and fruit conditions result in great fly abundance, the presence of favored fruit does not give much immunity to less favored sorts. As to citrus fruits, the grapefruit seems to be favored and the sour orange next. In general, the commercial types of oranges are not heavily attacked until they are fairly well ripened. A total of several hundred host fruits and vegetables are now known, some 72 having been recorded for Hawaii and 47 for the Island of Bermuda!

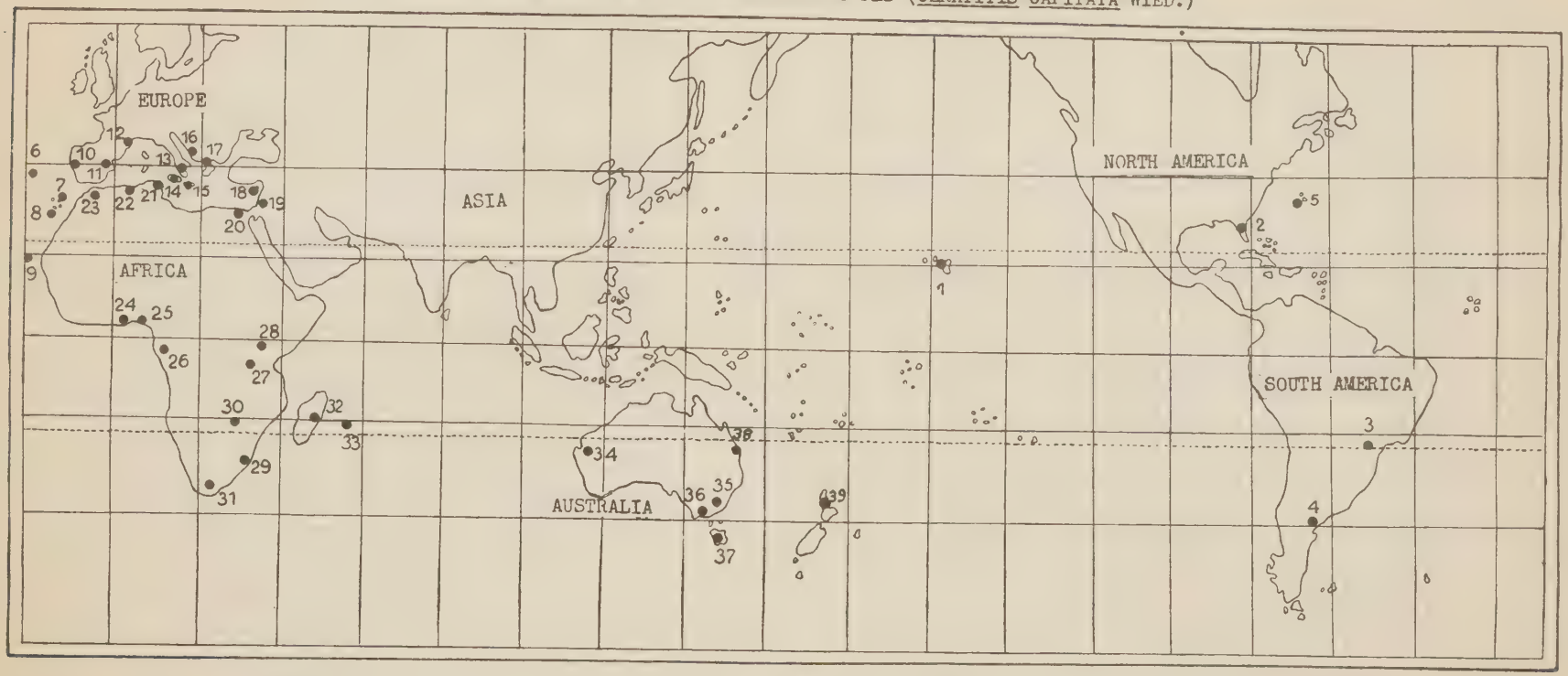
The important vegetables which are subject to attack of the fly include tomatoes, eggplants, bell peppers, lima and broad beans, and these are brought under restriction as to movement from Florida. With respect to tomatoes, the green tomato is believed to be immune to attack in the field and very rarely indeed are ripe tomatoes attacked. The fly will, however, breed in many other vegetables under forced conditions.

Control of the Fly in Foreign Countries.

In many of the foreign countries where the fruit fly occurs it is accepted as a visitation of Providence! In South Africa a determined fight has been made against the pest by spraying with poisoned sweetened bait, a method which originated there, and this method is briefly discussed in the attached paper on Mediterranean fruit fly conditions in other countries, etc. The same method of poisoned bait has been tried in the States of Australia and in Hawaii, in the latter country at least with practically no success; and a substitute therefor of parasitic control has been developed, the results of which are discussed briefly in the paper just referred to under the heading of Hawaii. In Spain and other European countries the control, if it can be called such, is practically limited to what appears to be a normal cleanup of orchards, namely, the elimination during and at the close of harvesting of all fallen and discarded fruit so that at the end of the season the orchard is bare of any waste fruit either in the tree or on the ground--a control measure undoubtedly of high importance if the fruit so removed is properly disposed of, either by feeding to animals or by burying. In general, however, the controls in foreign countries are those merely which Nature provides, namely, climatic. In addition to such controls, a great deal of fruit is saved and enters into consumption by the habit of picking many fruits while still comparatively green; in other words, before they reach a stage of attractiveness to the fly. This in Hawaii applies to the mango and the papaya, two abundant and common food products in these Islands, and applies also to the early harvesting and picking of the crop of citrus fruit in Spain in midwinter, and to similar conditions which apply to winter-ripening oranges in Brazil, Italy, and other countries. As indicated in the discussion referred to, the temperature conditions in midwinter in such European countries are such as to practically stop fly activity, and this gives an opportunity to harvest and dispose of crops of citrus fruit with relatively small loss, although a certain percentage of all such fruit which enters into commerce is undoubtedly infested.

In the United States, if this pest is not eradicated, its control would remain a continuing and very expensive factor, involving all of the cleanup operations which we are now enforcing as a feature of the eradication campaign, namely, the picking up and destruction of windfalls in the orchards throughout the ripening season of the fruit, the limitation of the harvesting season, the prompt picking of all fruit and cleanup of orchards at the end of the stated period, the maintenance of a nonhost fruit period throughout the summer months, together with frequent sprayings. As long also as the fruit fly was limited to Florida or restricted districts of the United States, it would probably be necessary to enforce the present burdensome and expensive quarantine controls to delay as long as possible the spread of the pest to other important fruit sections, including fruit and vegetable sterilization and packing house, transportation, and marketing controls.

DISTRIBUTION OF THE MEDITERRANEAN FRUIT FLY (CERATITIS CAPITATA WIED.)



1. Hawaii, 1910
2. Florida, 1929
3. Brazil, 1901
4. Argentina, 1905 (?)
5. Bermuda, 1865
6. Azores, 1829
7. Madeira, 1827
8. Canary Island ___
9. Cape Verde Island, 1829
10. Portugal, 1925
11. Spain, 1842
12. France, 1900
13. South Italy ___
14. Sicily ___
15. Malta, 1875
16. Albania, 1916
17. Greece, 1916
18. Zyprus ___
19. Palestine, 1904
20. Egypt, 1904
21. Tunis, 1885
22. Algiers, 1859
23. Morocco, 1921
24. Dahomey, 1910
25. Nigeria, 1910
26. Congo, 1910
27. Uganda, 1909
28. British E. Africa, 1914
29. Delagoa ___
30. Rhodesia, 1912
31. South Africa, 1840
32. Madagascar, 1914
33. Mauritius, 1817
34. W. Australia, 1897
35. New South Wales, 1898
36. Victoria, 1907
37. Tasmania, 1899
38. Queen's Land ___
39. New Zealand (?)

Adapted from J. Van der Vecht, 1929.

MEDITERRANEAN FRUIT FLY CONDITIONS IN OTHER COUNTRIES VS. UNITED STATES

Relation of Climate

In any examination of fruit fly abundance and damage, it is apparent that climate, and particularly that of the winter season, is the important controlling factor. Next in importance is the availability of host fruits the year round. It is of interest to examine the influence of these factors as they obtain in other countries and particularly in the great Mediterranean Basin, where the fly has been established as to some points for nearly a hundred years and quite generally for the past forty or fifty years. With respect to European countries it may be noted that all those touching on or projecting into the Mediterranean lie practically altogether above latitude 40, namely, the latitude of Philadelphia and bordering Kansas on the north and crossing northern Colorado and northern California. The only exceptions are the southern half of Spain and the extreme tip of Italy, including Sicily and the southern half of Greece. While the temperature of these countries is materially affected by the Mediterranean and the air currents from north Africa, nevertheless the high latitude means a shortened summer and a lengthened autumn and spring, namely, temperature conditions for at least six months of the year which greatly restrict fruit fly activity and check it almost completely for at least three months. This is especially true of France, Spain, and Italy. As illustrating conditions in southeastern Europe, it may be noted that Constantinople has a winter more comparable to that of Washington, influenced as it is very much by the cold winds from the Black Sea.

By contrast, it may be noted that Florida lies largely between latitudes 25 and 31, and the Gulf States, taken as a whole, between latitudes 25 and 35, and, in addition, this area has the favoring influence of the Gulf of Mexico and the Gulf Stream.

To better illustrate fruit fly possibilities in the United States I have had charted the mean temperatures by months of important fruit fly centers, covering for each point a series of years, and introducing for comparison the corresponding temperatures obtaining at Orlando, Florida.

The first of these diagrams or charts compares mean temperature conditions obtaining at Orlando, Florida, and at certain other points in the Gulf States with Paris, France, where important fruit fly invasions have been experienced. It will be noted from this diagram that the mean temperature for January at Orlando, Florida, the center of the invaded area, is 25 degrees Fahrenheit higher than Paris. It is to be noted also that intermediate between Paris and Orlando in winter temperatures in order of succession are Nashville, Tennessee, Macon, Georgia, Charleston, South Carolina, and Mobile, Alabama. In other words, at all of these points the winter climate is more favorable to the fruit fly than it is at Paris. Furthermore, the summer in the South, and even throughout much of the United States, is warmer and much longer than it is normally in southern Europe, and cultivated host fruits, peaches, etc., are in much greater extent than in Europe. There is therefore a very patent risk of the fruit fly invasion extending northward and becoming fully established at least in the Cotton Belt States, with likelihood of temporary or seasonal establishment in States farther north.

The mean temperature records for important fruit centers in Mediterranean countries as compared with Orlando are the subject of the second of these diagrams or charts. A similar comparison with respect to important centers in the Southern Hemisphere is made in the third chart.

With respect to the Mediterranean points, it will be noted that Orlando has a much milder winter than any of these, including even Cairo, Egypt. Attention may also be called to the very low winter temperatures shown for Constantinople, the January-February mean of which is about 41. Comparing the mean temperature for January-February of these Mediterranean points with the same months for Orlando, we find the following order, beginning with the lowest mean: Constantinople, 41; Naples, 47.4; Athens, 48.5; Valencia, 49.8; Palermo, 51.2; Orlando, 59.

With respect to the points indicated in Diagram 3 for the Southern Hemisphere, it will be noted that Orlando, Florida, presents a milder winter than any of the points considered except Rio de Janeiro. Sao Paulo is charted to represent the coffee district of Brazil, which is also an important fruit fly center. Beginning with the lowest winter temperature, these points arrange themselves in the following order: Sydney, 53.8; Cape Town, 55.1; Sao Paulo, 58.5; Pretoria, 59.3; Orlando, 59; Rio de Janeiro, 68.6.

It is well understood that insect activity in general begins with a mean temperature of about 50° F., but in the case of the fruit fly, clearly a subtropical species, important acticity would begin at a somewhat higher temperature. This acticity increases to a maximum at temperatures of 70 to 80° F. It will be noted that while none of these temperatures as recorded go much below the point of possible insect activity, in the case of Orlando, Fla., the mean of the coldest months, January and February, is approximately 59° F., and rapidly rising from that point in October, December and February-March. These diagrams are in substantial confirmation, therefore, of the judgment that in Florida we have temperature conditions unusually favorable to the fly. In addition to that, Florida presents throughout the year an abundance and availability of fruit perhaps not equalled elsewhere, not even in Hawaii, because these Islands lack the citrus crop of Florida which, with other fruits, furnishes practically unlimited host fruit material throughout the year.

The mean monthly temperatures for all of the points covered in these charts are reproduced in tabular form, including the temperatures for Hawaii, and, for comparison, Washington, D. C.

While it is unlikely that the fruit fly would overwinter if actually subjected to the out-of-door temperatures which characterize the States north of the Cotton Belt, it must be remembered that the fruit is not kept out of doors but in situations favorable to the hibernation and survival of the larvae and pupae coming from infested unsterilized fruit. The pupae could remain in this stage until favorable outdoor temperatures existed in May or June for the emergence of adults. Furthermore, the adult fly has the power to live for many months, sometimes nearly a year. These conditions, together with our very long summers as compared with central and western Europe, might readily lead to summer and fall infestation of peach or any

DIAGRAM I.

MEAN MONTLY TEMPERATURE.

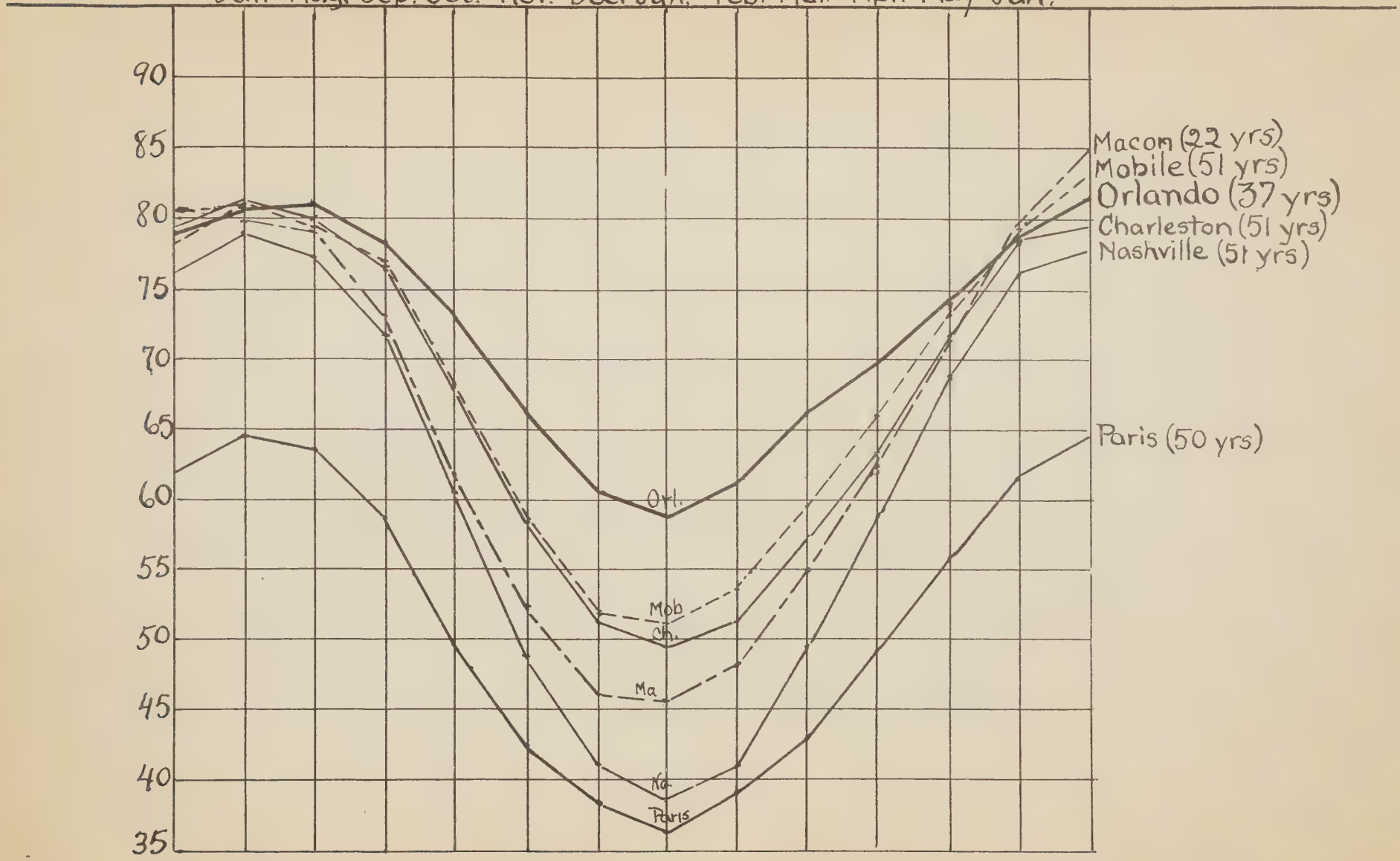


DIAGRAM II.

MEAN MONTHLY TEMPERATURES.

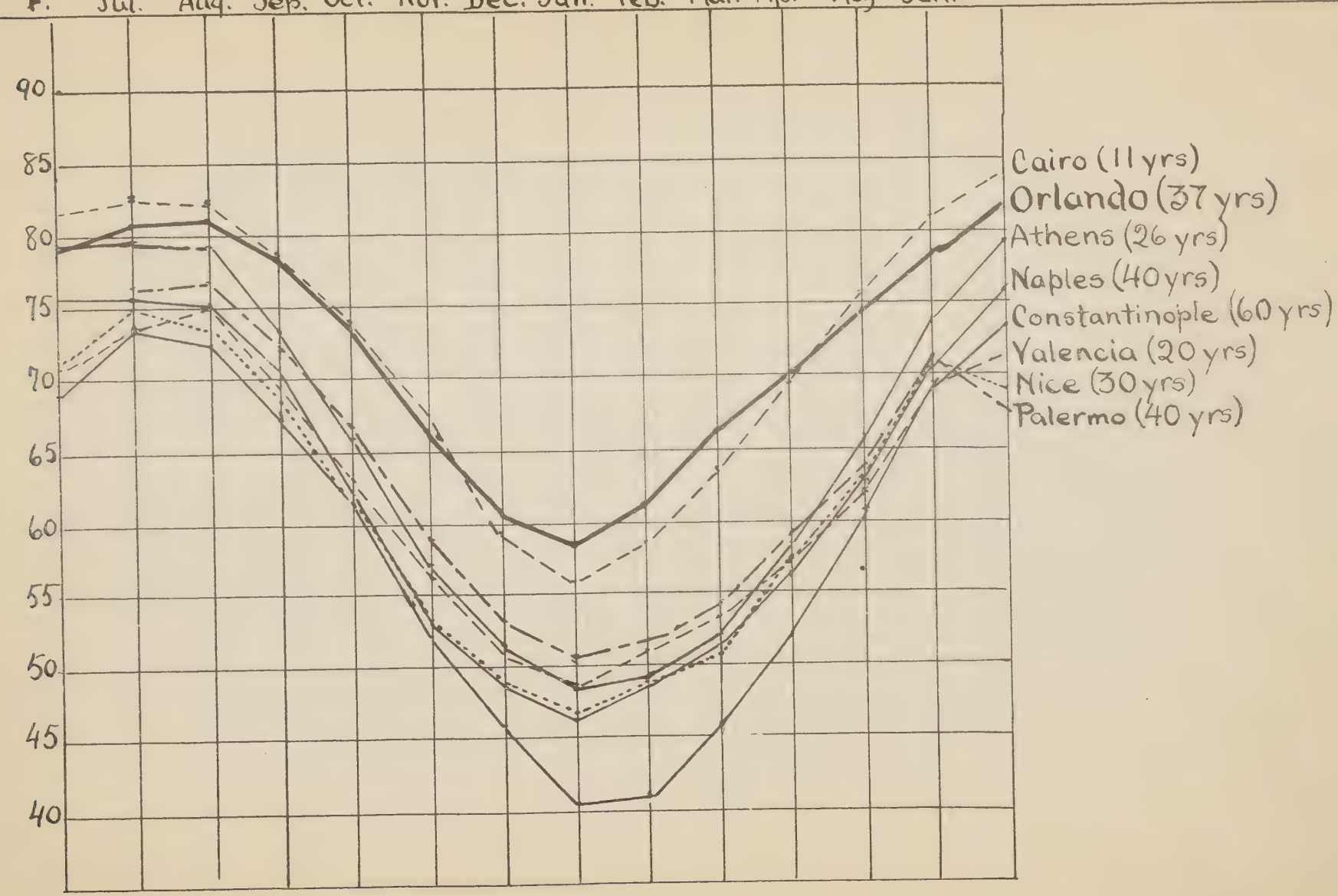
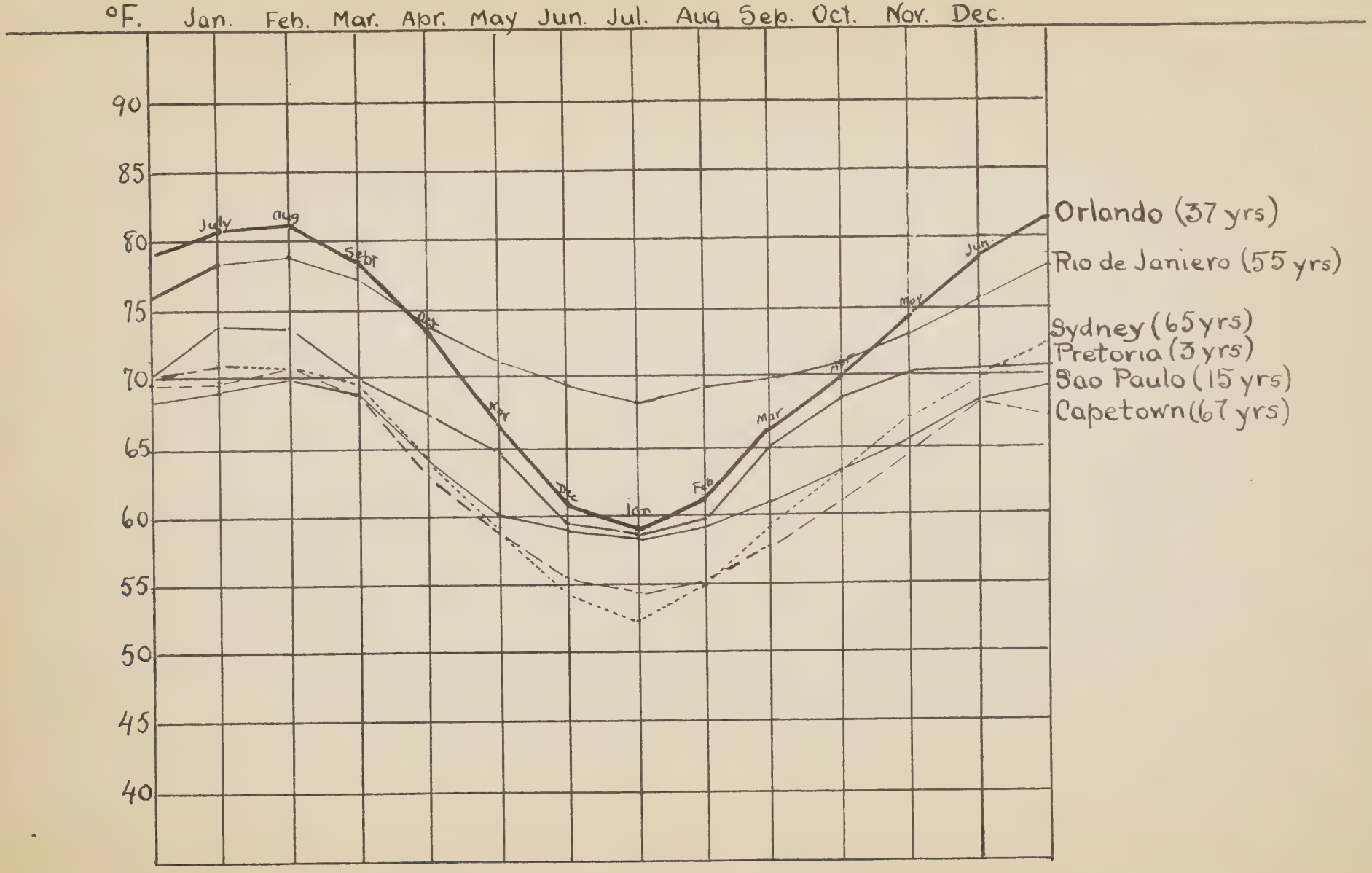


DIAGRAM III.

MEAN MONTHLY TEMPERATURES.



MEAN MONTHLY TEMPERATURES

Northern Hemisphere

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Years
Nice	47.1	48.8	50.9	57.6	63.9	71.4	75.	74.6	69.1	62.2	53.5	48.2	30
Valencia	48.4	51.2	53.4	57.4	62.6	69.4	74.6	75.	69.6	63.2	56.7	50.6	20
Constant.	40.6	41.0	45.7	52.4	61.	69.	73.	72.2	67.2	61.4	52.4	45.4	60
Palermo	50.6	51.8	54.6	58.6	64.	71.	76.4	76.6	73.	67.	59.2	53.4	40
Cairo	55.9	58.1	63.7	69.4	75.4	80.6	82.6	82.4	78.3	74.3	67.5	59.2	11
Naples	46.6	48.2	51.4	56.6	63.2	70.2	75.6	75.2	70.4	62.6	53.	48.9	40
Athens	46.4	48.7	52.2	58.6	66.	74.2	79.6	79.4	73.4	66.	57.2	52.	26

Southern Hemisphere

Rio	77.6	78.	77.	74.4	71.2	69.2	68.	69.2	69.8	70.8	73.2	76.4	55
Sao Paulo	68.9	70.	68.	64.6	60.4	58.6	58.	59.	61.6	63.	65.6	68.	15
Pretoria	73.6	73.4	70.	67.2	65.	59.8	58.8	59.9	65.	68.	70.	70.	3
Capetown	69.9	70.3	68.1	63.2	58.9	55.7	54.7	55.6	57.9	61.2	64.4	67.9	66
Sydney	71.7	71.3	69.3	64.7	58.8	54.6	52.7	55.	59.2	63.5	67.1	70.1	66

Miscellaneous

Honolulu	70.5	70.7	71.1	72.7	74.6	76.2	77.3	78.1	78.0	76.8	74.6	72.6	14
Paris	34.8	39.2	50.3	49.2	56.2	61.6	64.6	63.9	58.4	50.	42.4	36.0	50
D. C.	33.6	34.7	42.9	53.6	64.1	72.3	76.5	74.3	68.2	56.9	45.5	36.4	51

other deciduous fruits grown in these States. The rapidity also with which this insect develops makes it entirely probable that it could increase in the North during a single season in such numbers as not only to occasion serious damage locally but also to lead to its spread into States to the South, where it could gain firm and continuing foothold.

From the standpoint of climate and opportunity -- abundant host fruits the year round -- Florida is apparently the most favorable region for the fruit fly yet reached by this pest. On the record of last spring, in what is the probable center and origin of the invasion, there was exhibited a much greater infestation than has ever been reported as to citrus fruits elsewhere -- namely, in the case of several orchards, from 75 per cent to practically 100 per cent infestation. This applied to grapefruit -- oranges in the same orchard being much less infested. The winter temperatures at Orlando, which is central to the main citrus area of the State, are rarely such as to more than check for a period of two or three months the breeding activity of the fly, and in point of fact it seemed to be evident that in the winter of 1928-29 such activity was little, if any, reduced, as indicated by the conditions obtaining in the first week of April, 1929.

The countries reached by the Mediterranean fruit fly which perhaps most approach Florida in conditions, both climatic and in host fruit availability, are the Union of South Africa and New South Wales and other States of South and West Australia, and in these countries fruit fly damage has been very heavy. The Hawaiian Islands, lying between the latitudes 20 and 23 north and with continuous fruit production, present conditions very favorable for the fly, affected, however, by the cooling trade winds which are continuous for practically all of the year and in the winter by the humid rainy season.

A more detailed discussion of fruit fly conditions in important countries reached by this pest follows.

FRUIT FLY IN SOUTH EUROPEAN AND MEDITERRANEAN COUNTRIES

Fruit Fly in France

The fruit fly has been permanently established in the Mediterranean or Riviera district of France for a half-century or more. The damage varies somewhat from year to year, being more apparent in stone fruits, pears, etc., than in orange. The winter period in this district is fairly long, on account of the latitude (about that of Boston) and the temperatures run pretty low, so that the fly is inactive or in hibernation as larvae, pupae or adults during a long period, and normally becomes injuriously abundant only towards the end of the summer. Under these limitations, the fly population is largely absorbed by its favored host fruits -- peaches, pears, etc., which are regularly and often seriously injured. Normally the fly occasions only minor damage to the rather limited citrus production of the area. The important grape cultures of South France are not injured, and it is well known that, while the fruit fly may and occasionally does breed in grapes, important or commercial injuries to this type of fruit are unusual.

The particular interest as to France is the record of the outbreaks of this fly in important peach and prune areas in the neighborhood of Paris (latitude of Newfoundland). An important outbreak of this pest in this region in 1900 is re-

corded, when very considerable crop losses were experienced. Either that this infestation continued in a minor way or that new introductions of the pest were made, is indicated by the record of a similar infestation in 1906 and of the occurrence of this pest again in October, 1914. I have elsewhere indicated that the temperatures of Paris, winter and summer, are lower than the corresponding mean monthly temperatures of important towns in the Cotton Belt, including Nashville, Tennessee, Macon, Georgia, and other points to the South. The indication that this gives of the distinct risk to the fruit cultures at least of the Cotton Belt States is perfectly clear, particularly in view of the much longer as well as warmer summers in these States, as compared with France.

Fruit Fly in Spain.

Spain is subject to climatic conditions, elsewhere discusses, not altogether favorable to the fly. Spain is further fortunate in that her great orange crop of the general Valencia-Murcia district ripens in December and January when the fly is at its lowest ebb of activity and finds at that period its principal market in England and middle Europe. The fly, while present during this period, is inactive on account of the low temperatures and only a slight percentage of infestation occurs. It is this condition which gives Spain her opportunity to move the bulk of her citrus crop successfully. On the other hand, the small portion of the crop which is left on the trees, more particularly to supply the local markets of spring and summer, becomes, as the season advances, heavily infested, eventually often 100 per cent.

The following notes and records will assist in giving a better understanding of fruit fly behavior in Spain, more particularly as affecting the orange crop elsewhere than in the Valencia district.

For a considerable period, permission was authorized for the entry of a type of orange from southern Spain (Seville) for manufacture of marmalade at factories in New York State on condition that the fruit would be so carefully selected that it would not be infested with fruit fly. After a short trial, this permission had to be withdrawn because of the high degree of infestation which was found in such fruit, evidently resulting from the fact that, for the manufacturing purpose involved, it had to be well colored and hence well ripened, giving the maximum opportunity for infestation. By inspection the condition of this fruit could not be determined with any accuracy, as was exhibited by the subsequent inspection that was made of it during the time it was being utilized at the factory. The following paragraph taken from a report submitted by Inspector C. E. Cooley, January 27, 1925, indicates this situation:

> "I spent, in all, about a half-hour examining the oranges as they were being sorted and quartered in the first room, and discovered only one live larva of Ceratitis capitata and one pupa, badly crushed, which appeared to be that of the fruit fly. However, the most striking feature, to me, developed in this investigation, was the fact that with only a few moments' examination, 5 live larvae of the fruit fly were found in the oranges which had already been sorted; were on the tables where the skins and pulp were being separated; and which, although apparently per-

fect outwardly, were being discarded into a basket by the girls when the pulp showed a considerable rotted condition. All this taking place in the processing room, being maintained at a temperature above 60 deg. F. In fact, after a few minutes, the girls were beginning to pick out specimens of live fruit fly larvae and giving them to me. Mr. Cottam at this time instructed the forelady to have these discarded fruits removed to the boiler room at the close of the day and burned."

The conditions during the last shipping season in Spain, 1929-30, are indicated in letters from Dr. H. J. Quayle of December 3 and December 25, 1929, quoted in part below, covering a survey conducted between November 19-25, 1929.

"December 3, 1929. Advised that the injury ranges from 1 to 10 per cent -- from his own examination, nearer 1 than 10. Flies still present, but owing to cool weather doing very little egg laying. "Many oranges are stung but they are eaten before -- or shortly after -- the larvae do any important damage." * * * "Oranges are being harvested and shipped in great quantities."

"December 25, 1929. Referring to 3 days spent in the vicinity of Murcia, where the temperature is a little warmer than it is in Valencia, and there is a considerable acreage of apricots and other deciduous fruits, Quayle reports "no great difference in the fly population or in the number of infested fruits", as compared with Valencia. Speaking of the Valencia district, including Murcia, he says: "I have been in the field nearly every day since arriving here and there has been no time when I couldn't find flies if I looked long enough. The thermometer registered at freezing for a few hours one night but I found flies on the sunny side of an occasional orange tree the next day . The weather has been dry and generally warm during the day and this accounts for the flies still occurring on the trees. If the usually cold and rainy weather had occurred the flies would have disappeared by this date." * * * "From my own observations and what I have been able to learn from others, the adult flies disappear for the winter, under the conditions here, in December, and, if the weather is fine, as this year, a few may persist into January. So far as I have been able to determine, there has been no egg-laying for the past two or three weeks and I have found no fruits with young larvae. During the same time no eggs were deposited in fruits for the purpose that were placed in the insectary."

This statement gives a very good picture of the fruit fly conditions in December January, during the period when the main citrus crop of Spain is ripening and being marketed, and indicates the reason why this, the important Spanish fruit crop, marketed in these months, suffers very little from the fly.

Fruit Fly in Italy

In general, the climate of Italy is very much less favorable to the fly than it is in Florida and probably in the warmer portions of the Cotton Belt. It becomes cold enough very often over most of Italy during the long winter season (latitude of New England) to stop fly activity, even as far south as Sicily, for a period of several months. At Naples the fairly extensive orange orchards are protected from frost by temporary sheds of brush on high supporting poles, maintained each winter. Considerable damage to miscellaneous other fruits from midsummer on is a common thing, however, in southern Italy and especially in Sicily, and this is true also, at the end of the season, as to oranges, especially when they become fairly well ripened.

Some notes regarding infestation in Italy follow:

In Bulletin No. 134, U. S. Department of Agriculture (1914), on page 4, H. J. Quayle writes:

> "When the writer returned to Sicily on the first of August such ripe oranges as were still on the trees or on the ground were heavily infested with the fruit fly. Indeed, no oranges could be found that were either not infested or did not show punctures."

The following is quoted from H. J. Quayle's letter of August 9, 1913, to Dr. C. L. Marlatt at the time Chairman of the Federal Horticultural Board:

> "I arrived in Palermo a week ago and have found plenty of Ceratitis in oranges and peaches, and to some extent in pears and plums. I happened to find one place where about 90 per cent of the oranges, mostly on the ground, are infested."

Up to recent years, importations of well-ripened bitter oranges from Sicily were permitted to enter at the port of New York for immediate shipment in bond to Canada, chiefly for the manufacture of marmalade. On account of the serious infestation of this fruit with the fly, it becomes necessary to rescind the permission to move such fruit in bond by rail from New York to Canada. The two attached letters indicate the condition of shipments of selected fruits.

 February 9, 1928.

Mr. Romolo Angelone,
Commercial Attache, Italian Embassy,
2700 Sixteenth Street, N. W.,
Washington, D. C.

Dear Mr. Angelone:

Your letter of February 8 (1514) referring to a shipment of five hundred cases of Italian bitter oranges, which recently arrived on the SS Carnia for I. T. Shipment to Canada, has been received. Although you do not so indicate, I presume you are aware of the fact that this shipment was found to be heavily infested with the Mediterranean fruit fly, one of the most injurious fruit insect pests known. Not only were larvae taken from the fruit, but adults in great numbers were found flying in the hold of the vessel. Fortunately, this insect does not occur in this country, and hence, every precaution is being taken by this Department to prevent its establishment here.

Prior to the arrival of the shipment, a permit was granted, authorizing the immediate shipment of this fruit in bond, by rail, to Canada. This permit, however, was granted on the condition that the rail shipment to Canada was contingent upon apparent freedom of the fruit from infestation by the Mediterranean fruit fly and other injurious insects. The finding of this insect in such large numbers makes it necessary to require the shipment of the oranges out of this country immediately, and if this fruit proceeds to Canada, it must go by all water route. To effect the shipment by this method, Mr. Freeman has been authorized to permit the transfer by lighter, of the infested fruit, under such safeguards as he may prescribe, from the SS Carnia to the vessel proceeding to Montreal.

To add to our difficulties, we have just been advised that the SS Carnia will shortly proceed to Philadelphia to discharge cargo, later returning to Italy via New York.

From the standpoint of infestation, the shipment in question represents one of the most serious pest risks which has developed in connection with the entry of fruit in recent years. In view of this condition and the risk which evidently accompanies shipments of Italian bitter oranges, this Department can no longer issue permits authorizing the entry of Italian bitter oranges for shipment in bond by rail to Canada.

Very truly yours,

(s) C. L. Marlatt,

Chairman of Board.

January 31, 1925.

Report of Inspection of Sour Oranges ex S. S. Saucon.

This examination was made on Milton Street Pier, Brooklyn, January 30, 1925. The material examined was a lot of 100 cases of sour oranges in bond to Montreal, Canada, entered by Bridgetts & Company, entry Exp. 86835, permit 372, marked A 1 Matteo Maniscalco Palermo; origin, Palermo, Sicily. The steamer carrying this material left Palermo on January 8 and arrived in New York January 27. The fruit was carried in an ordinary air-ventilated hold, the steamer carrying a cargo of about 17,000 cases of Sicilian lemons in addition to general merchandise from Mediterranean ports.

Only one box was opened for inspection. In this box were found 18 actually infested oranges, 14 of which were dissected and larvae removed, and the other 4 submitted as live material for rearing. The latter 4 were not cut open but sent in intact. In the 14 dissected here were found 85 live larvae, ranging from very small, about an eighth of an inch long, to full grown. All were alive and active. From 2 to 18 were found in a single orange. In addition, 2 live larvae, 5 pupae, and 1 empty pupa case were found adhering to the paper and bottom of this box. Assuming that the four oranges submitted contain the average number of larvae, this one box had a Mediterranean fruit fly population of 109 larvae and pupae, and if this same average continued for the entire 100 cases, it would make 10,900 Mediterranean fruit flies for the shipment. The oranges were packed 200 to the case, all of which were examined in the one case opened. This makes an actual infestation of 9 per cent of the oranges in this case. The oranges in this case were of a very big grade, having the rich reddish orange color of fully ripened fruit, which had hung a long time on the tree. The larvae were found in oranges which had an externally normal appearance, but which had a spongy, light feeling. Some showed prominent exit holes. This box of 200 contained only three decayed oranges, none of which were found to be infested.

The material was submitted as follows:

4 undissected oranges for rearing.
1 vial with the larvae and pupae found on packing.
1 vial with 86 larvae taken from the oranges.
N. Y. interceptions 5468 and 5469.

E. Kostal.

Wm. H. Freeman,
Chief Inspector.

A note submitted by the New York Inspector relative to the shipment discussed in the attached letters is of interest:

"The oranges were inspected during one of the coldest spells of the present winter. On February 6 when examination was made the official outside temperature ranged from 18 degrees Fahrenheit at 10 A.M. to 25 de-

grees Fahrenheit at 1 P.M. In the ship's hold, due to the natural heat generated by the fruit, the temperature was at about 55 degrees Fahrenheit (estimated). However, live flies were found on the dock that same afternoon. The temperature inside the dock shed was kept slightly above freezing in order to protect perishable cargo."

Such infestation was practically a continuing feature, as shown by examinations of succeeding shipments.

Fruit Fly in Madeira Islands (Portugal).

The following is an excerpt from the Review of Commerce and Industries for the quarter ended September 30, 1929, submitted by the American Consul, J. K. Huddleston at Funchal, Madeira Islands, to the Secretary of State, dated October 10, 1929:

" At one time Madeira produced very good oranges in considerable quantities but the Consulate is informed that fruit fly discouraged farmers from further attempts to raise citrus fruit here, and orange growing on the Island has practically disappeared."

Fruit Fly in Greece.

From the American Consul, C. B. Cooke, Patras, Greece, November 27, 1918, in a report sent to the Secretary of State in accordance with telegraphic circ; Inst., Oct. 19, 1918:

"The Patres consular district has been visited again for the third successive year by the Mediterranean fruit fly (Ceratitis capitata), which has committed terrible ravages among the orchards and gardens throughout the district. It has attacked apricots, citrons, mandarines, nectarines, oranges, pears, peaches, plums, among orchard crops; and among garden crops, eggplant, marrows (vegetable), melons, tomatoes. Even lemons, which in past years have been immune, have been attacked to some extent this year. The losses in the above crops due to this fly have reached 80 per cent in some parts of the district, with an average of 60 per cent for the whole district. Most of the fruit fell before maturity in a rotting condition, and such as remained on the trees or plants was found infested with the larvae of the fly.

"The losses will have little direct effect upon the export trade of this district, as practically the only fruit concerned which enters into that trade is the citron, which has in past seasons been shipped in moderate quantities in brine to the United States. The loss of these crops will be keenly felt, however, among the people at this time when there is such shortage in foodstuffs."

From the American Consul, A. B. Cooke, Patras Greece, Dec. 6, 1916, in a report to the Secretary of State.

"The tangerine crop was practically a failure, owing to the ravages of this fly. Most of the fruit fell before maturity; and such as matured and was brought to the market was infested with the maggot of the fly. The orange crop also suffered severely, great part of the fruit falling before maturity and the remainder being of inferior quality. The peach and pear crops were a failure, very little of this fruit even reaching the market."

Fruit Fly in Other Mediterranean Countries and Islands.

A few records are appended to indicate conditions in the Mediterranean and countries to the south.

Fruit Fly in North Africa

Mr. Chas. P. Lounsbury, Govt. Entomologist of the Cape of Good Hope, in an article on the Mediterranean fruit fly in Agricultural Journal, Cape of Good Hope, vol. 27, 1905, p. 311, quotes a letter from a Mr. Bioletti." "Mr. Bioletti, until recently was horticulturalist at the Elsenburg Agr. College, and when he wrote in December last, he had just completed a tour through French and Algerian fruit districts. He said: 'Algeria ought to be a good place for fruit growing but the fruit fly makes it impossible to grow any but the earliest varieties and there only in a few localities'".

Fruit Fly in Algiers and Tunis

The following from an article by L. Guillochon entitled "LePecher dans le nord d'Afrique" (The Peach in North Africa) has been translated by Mr. H. B. Shaw from La Vie Agricole et Rurale, xxix: 52, pp. 407-408, Paril, December 1926.

"In the course of a mission in Algeria and Tunis, entrusted to me in 1912 by the technical Commission of Experimentation of the Director General of Agriculture, Commerce and Colonization of Tunis, I demonstrated that the culture of the peach was limited to the production of early varieties of peaches and that the exportation of this fruit was almost, or entirely, non existent.

The purely local sale was caused by the almost exclusive culture of early varieties called "Soft", whose fruits, which ripen from June to early July, thus escape the ovipository period of the females of Ceratitis capitata and whose texture and watery character do not admit of transportation for several days, even with the most favorable packing conditions.

As opposed to "Soft" peaches are the "Hard" peaches produced in California for canning. This second class of peach is

not too watery, thus permitting their skinning by machine, the flesh of the fruit being preserved entire without assuming a mushy consistency in the preserving liquid.

"Unfortunately these varieties are late here; they do not ripen until August and September, are invaded by the fruit fly, and are useless on that account.

"To my knowledge at least, these conditions of sale have not changed since 1912 and the trade in peaches remains local for the reasons which have just been indicated."

Fruit Fly in Palestine

The following is quoted from Dr. F. S. Bodenheimer in the First Report 1921-6, November, 1926, Zionist Organization, Institute of Agriculture and Natural History, Agricultural Experiment Station, Palestine:

"The climatic conditions are so different in various parts of Palestine, that special research is necessary in each. This is demonstrated in the life history of the Mediterranean fruit fly (Ceratitis capitata), the most serious pest of oranges and of deciduous fruits, which in the coastal plain has 7, near Jerusalem 5, and in the Jordan Valley 10 generations per annum."

Fruit Fly in Cyprus

The following is quoted from D. S. Wilkinson, in the Cyprus Agricultural Journal, vol. xx, part 1, January, 1925, pp. 9-10.

"Ceratitis capitata, Wied., is recorded from oranges, tangerines, figs and apricots from all over the Island, and causes great damage."

FRUIT FLY IN OTHER COUNTRIES

Fruit Fly in South Africa

The following is quoted from an article by Chas. P. Lounsbury, Government Entomologist, entitled "Natural Enemies of the Fruit Fly" which appears in The Agricultural Journal of the Cape of Good Hope, Vol. XXVI, No. 1, January 1905, p. 84:

"Fruit flies are the greatest pest to fruit that we have in South Africa. The principal species, Ceratitis capitata, blows nearly all of our Cape grown fruits, though some kinds much more commonly than others. In some parts of the Colony few peaches escape the attack, and often most of the soft fruits maturing after about Christmas get blown. The pest varies in abundance from year to year, and, in general, probably owing to the greater prevalence of wild fruits, is worse in eastern sections than in western."

The fight against this pest in South Africa has been a continuing one for some 25 years, and the sweetened bait remedy, I believe, originated there and has been the main reliance for control. The bulletins issued by the Department of Agriculture of the Union of South Africa indicate, however, the necessity for spray-

ing every 7 to 14 days throughout the period when fruit becomes attractive to the fly until it is harvested, involving the cost of many applications throughout the season. As is normal, the citrus fruit, particularly oranges, suffers less than stone fruits and also apple, pear and quince, but as elsewhere practically all fruits are subject to serious attack. Even under this treatment, 25 per cent or more of the fruit is commonly lost and a good deal of the fruit shipped is also maggoty, as interceptions of such fruit at ports of the United States have clearly indicated. Sterilization by refrigeration was attempted but failed, apparently because it wasn't realized that to effect killing of larvae it was necessary to carry the fruit two or three degrees below the freezing point of water. The fruit, however, was subject to a fairly low degree of refrigeration, namely, between 32 - 34 degrees Fahrenheit. As indicated in an official report, fruit held at such temperatures for a period of six weeks and thereafter shipped under refrigeration to England yielded numbers of flies after arrival at destination. Fruit fly conditions in portions of South Africa are comparable to those in Florida, but in fruit abundance particularly, and also in variety, the conditions are apparently less favorable than in Florida.

Fruit Fly in Australia.

The distribution of the fruit fly to the remote points of the world, like Australia, is due to the great improvement of facilities for carrying fresh fruits on shipboard under refrigeration. In connection with such fruit, probably from South Africa, this pest was introduced in Australia some time shortly prior to 1897. It was noted in that year in Western Australia and the following year in New South Wales, later reaching Victoria, South Australia, and Tasmania. In latitude this general region corresponds to our Gulf States and Florida, Tasmania having the latitude of 40 to 44 degrees South. The fly also obtained, probably independently, at least a temporary foothold in the North Island of New Zealand. In New South Wales this pest has been particularly disastrous to fruit productions, and even in Victoria, farther south and hence in a cooler climate, its damages have been heavy, as indicated by the following paragraph quoted from the Government Entomologist of Victoria, 1907:

> "This terrible scourge (the Mediterranean Fruit Fly) of the fruit grower is becoming but too familiar in Victoria, the larvae having been found in peaches, pears, quinces, apricots, plums, nectarines, bananas, guavas, oranges, lemons, apples, citrons, loquats, mangoes, pumpkins, tomatoes, pineapples, and persimmons; so that it will easily be seen that hardly any fruit can be said to be exempt from its attacks, and of all the fruit grower's enemies the fruit fly is undoubtedly the worst."

A similar official report from Western Australia (Department of Agriculture, 1924) includes the statement:

> "The fruit fly is undoubtedly the worst pest we have to deal with in this State. In 1914 the ravages of this fly were so widespread that it became a question of who was to exist -- the growers or the fly."

Illustrations are given in this bulletin showing heavily infested apples, pears, quinces, peaches, oranges, loquats, passion fruit, grapes and even seed pods of roses.

FRUIT FLY IN BRAZIL

The fruit fly was introduced into Brazil certainly 25 or 30 years ago, and perhaps much earlier. Mr. C.P. Lounsbury, Government Entomologist of Cape of Good Hope, who visited Brazil in 1905 particularly for the purpose of possibly securing parasites there to establish in South Africa, in a report to the Agricultural Journal of the Cape of Good Hope of 1905, makes the following statement concerning fly conditions in Brazil:

> "The fruit fly of South Africa, Ceratitis capitata, is a very severe pest in the States of Rio de Janiero and Sao Paulo, and probably in other parts of Brazil where peaches are grown; practically all of the fruits allowed to mature on the innumerable peach trees in the States named nearly every year become infested by maggots, and this species of fly is believed to be the only one chiefly implicated."

In Brazil, as in other countries, the fruit fly evidently exhibits a very distinct preference for peaches and other stone fruits, and the coffee berry, which there as in Hawaii is perhaps one of its most favored hosts. Of citrus fruits, the grapefruit is most severely attacked; and oranges, ripening as they do in the winter season, are comparatively little attacked until they are well ripened so that the crop, as in Spain, can be shipped with comparatively a small percentage of infestation and loss.

FRUIT FLY IN HAWAII.

The fruit fly was introduced into Hawaii in 1910 as a result of an infested ship from New South Wales coming into the harbor of Honolulu. No fruit was landed, but the flies had developed numerously from ship's shores and were flying about in the ship, and some of these made the short flight from the shore to fruit which was abundant throughout the city and suburbs. A few months later the infestation was quite general in the city and within three or four years it had extended throughout the Hawaiian Islands.

The climate of Hawaii is peculiarly favorable to the fruit fly, except that during the winter period there is a great reduction, due to the rainy season and so some scarcity of favored host fruits. Some recent statements have been made about Hawaii, which evidently are based on a misinterpretation of conditions as they appear during this rainy season.

An effort was early made by the authorities and persons in interest in Hawaii to control this pest by introduction of parasites. Such introductions were successfully made, and a very considerable parasitism has resulted, of which careful statistical record has been kept since 1915. These records are based on miscellaneous collections of fruit obtained each year from 30 to 50 or more different localities in the Islands, and involve, for the period, examination of many hundreds of thousands of fruits. The amount of infestation of fruit has been fairly uniform

in spite of the parasitism, which frequently reaches, in favorable types of fruit, 50 per cent, or more, of the maggots. The enormous fecundity of the insect, however, prevents even that amount of parasitism from very much, if any, affecting the average yearly percentage of maggots per fruit. For example, an examination of upwards of 100,000 Chinese oranges collected during the last three-year period (1922-24), covered by the latest fully tabulated report, indicates an average of 2.4 maggots per fruit. Similarly, the peach showed an average of 18.4 maggots per fruit for the same period, and the fig 5.1 maggots per fruit, etc. The nine-year average for these same fruits is, for the orange, 3 maggots per fruit, but for the peach and fig the same as the three-year average, and with other fruits a similar uniformity is shown.

The fully tabulated records for the three-year period for 1925-27 have not be submitted, but brief monthly statements have been received. As indicating the situation for the latter half of the year 1929, the following record of fruit infestation by months is reproduced:

Month, 1929	No. of Lots Collected	No. of Fruits Examined	No. of Larvae Found	Average No. of Larvae per Fruit
June	51	5,920	16,563	2.8
July	44	4,186	23,666	5.7
August	51	4,157	13,871	7.7
September	47	4,680	19,783	4.2
October	44	3,371	15,683	4.7
November	56	4,573	18,683	4.1
December	44	3,614	10,688	2.9

As further indicating fruit fly conditions in Hawaii, the following is quoted from Bulletin 640 of the U. S. Department of Agriculture published April 8, 1918, and based on records made by the Department's investigators in Hawaii.

> "In tropical and semitropical climates this fruit fly is capable of becoming a pest of prime importance and, as in the Hawaiian Islands, may be classed as the most important insect check to horticultural development.
>
> "This list shows that practically all the ordinary useful and edible fruits in Hawaii are infested heavily. Thus peaches can not be grown at present, for they are ruined before they become well grown; Chinese oranges, tangerines, figs, loquats, rose apple, many varieties of mangoes, certain avocados, guavas, coffee cherries, star apples, sapotas, persimmons, apples, pears, plums, nectarines, and quinces -- all these are badly infested." The bulletin gives a list of 72 host fruits of the insect recorded in Hawaii.

The nearest approach on the east of the Mediterranean fruit fly to the United States, prior to the infestation in Florida, was in the Bermuda Islands. This infestation apparently dates from 1865, when a vessel carrying a cargo of fruit from the Mediterranean regions was forced by a storm to discharge this fruit in Bermuda. Finding a favorable climate, the fly multiplied and very shortly put an end to what had theretofore been very promising fruit production possibilities, particularly as to the peach, which had been grown generally on the island and had been an important export. Some little effort was made to eradicate it, but with no thoroughness and no lasting benefit. It is understood, however, that interest in possible eradication has been aroused by the effort now under way in Florida. It would seem to be unquestioned that such eradication could be accomplished in Bermuda under its insular condition and limited area.

Following are extracts from two publications regarding fruit fly conditions in Bermuda. Col. W. R. Winter, in a bulletin entitled, "The Fruit Fly", published by the Bermuda Department of Agriculture in 1913, says:

> "With the exception of a few isolated cases, it has for many years been found impossible to grow perfect fruit in Bermuda; especially has this been the case with loquats and peaches: the latter are, even with the most primitive cultivation of excellent quality, and except for fruit fly, it would be an easy matter to produce enough for the requirements for the whole of these islands. Since the advent of the fruit fly, however, these fruits in conjunction with others, a list of which follows, have been practically destroyed by the rot which sets in as soon as the fruit is punctured and the maggots begin to feed, and the inhabitants have been deprived of a most valuable and necessary article of diet."
>
> Colonel Winter then gives a list of 45 fruits attacked by the fly.

In an article appearing on pp. 289-290 of the Bull. Ent. Research, Vol. XVIII, 1928, London, England, Lawrence Ogilvie says:

> "Peaches which formerly grew in great abundance in the island were rendered unproductive and loquats, sapodillas, Surinam cherries, peppers, and to a lesser extent, citrus, papaws, sugar-apples and guavas were severely infested."

Fruit Fly in the Canary Islands.

From a report of expedition to Africa in search of the natural enemies of fruit flies, Bulletin No. 3, Division of Entomology, Territory of Hawaii Board of Agriculture and Forestry, p. 13, by F. Silvestri, the following is quoted:

> "On the morning of July 30, 1929....I profited by the occasion to land and visit the fruit markets. I found these well supplied with peaches, pears, grapes and prickly pears, and among the ripest of the peaches I at once noted a number infested with Ceratitis capitata. I learned from the fruit vendors that the infestation sometimes becomes very severe, particularly later in the season, and that in September the prickly pears are also affected...."

The following is quoted from "Report on an Inspection Trip to the Canary Islands, 1927" by Max Kisliuk, Jr., pp. 3 and 6, submitted to Dr. C. L. Marlatt, Chief, Federal Horticultural Board.

> "Considerable oranges are grown in this (Telde, Gran Canaria) neighborhood. They are said to be heavily infested with Ceratitis capitata which affects the keeping quality and market in England.... I observed a few orange trees on which the fruit and some of the leaves were literally covered with Ceratitis capitata adults."

Fruit Fly in Madagascar

The following which appears on p. 133 of Vol. 8 (1920) of the Review of Applied Entomology, London, England, is from a review of an article by J. Legendre on pages 8-9 in C. R. Soc. Biol. Paris LXXXIII No. 1, (Jan. 1920).

> "Ceratitis capitata (Mediterranean fruit fly) is reported to cause serious injury to peaches in Madagascar, the damage amounting to about 80% of the total crop in January and even more in February. Each fruit may contain as many as six or seven larvae".